

# Mineral Parageneses, Fluid Characteristics and Radiogenic Isotopic Data from the Proterozoic Jasper Gold Zone, La Ronge Domain<sup>1</sup>

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A petrogenetic study of the Jasper gold zone was initiated in 1989 (Hrdy *et al.*, 1990) and is ongoing. Expansion and resolution of vein paragenesis and the application of fluid inclusion, stable and radiogenic isotope systematics has allowed derivation of fluid temperatures, pressures, sources, and possible ages. The past year of study has revealed the presence of a visible sericite alteration envelope which extends 2 to 3 m around the main structure. However, stable isotope data indicate that there is more laterally extensive cryptic alteration of the  $\delta^{18}\text{O}$  value of quartz in the host pluton. Muscovite, which on the basis of petrographic relations, is paragenetically related to gold in its present form, yields an  $^{40}\text{Ar}/^{39}\text{Ar}$  age of 1710 Ma. Single zircon  $^{207}\text{Pb}/^{206}\text{Pb}$  dating yields an age of  $1855 \pm 8$  Ma for the hosting Island Lake intrusion as well as surprising complex and variable early Proterozoic to mid-Archean ages for the altered margins of zircons hosted within the auriferous veins.

## 1. Vein Paragenesis

Petrography and electron microprobe examination of over 25 polished thin sections has revealed a complex mineral paragenesis and extensive mineral inventory from auriferous quartz veins (Figure 1). The concentration of minerals in the veins varies locally, but averages approximately 70 to 80 percent quartz and 5 to 20 percent pyrite with minor muscovite, biotite, chlorite, tourmaline, albite, carbonate, sphalerite, chalcopyrite, galena, marcasite, and trace gold, silver-gold tellurides, molybdenite, pyrrhotite, covellite, tetrahedrite, scheelite, monazite, rutile, and zircon. Uranium-rich solid inclusions in altered zircon rims have also been observed.

Quartz deposition has a prolonged history coincident with, and outlasting, structural deformation, as indicated by quartz grain recrystallization and cross-cutting relations. Gold occurs within cross-cutting fractures and microfractures which transect all other features, and is associated with recrystallized quartz subgrains. This indicates a relatively late introduction (or remobilization) of gold where pressure reduction, either within a brittle fracture or due to grain size reduction (volume decrease), caused gold precipitation. Brittle microfractures in rafted wallrock clasts in the veins host silver-gold tellurides (Fig-

ure 2) and are sites where potassium feldspar alters to albite. Silver-gold tellurides may be a manifestation of interaction between the auriferous fluid and the surrounding lithology and not necessarily a separate depositional event. Minerals paragenetically related to gold deposition include: muscovite, sphalerite, galena, minor pyrite, and trace monazite, molybdenite, scheelite, albite, and chlorite (Figure 1).

## 2. Fluid History

A formation temperature of 335°C was derived from quartz and muscovite oxygen isotope systematics (Eslinger, *et al.*, 1979). Muscovite is paragenetically associated with gold deposition and the quartz was selected on the basis of enriched gold content and development of grain size reduction. Due to complex mineral and fluid inclusion paragenesis, a pressure history for the Jasper vein is still unknown. Calculated  $\delta^{18}\text{O}$  and  $\delta\text{D}$  values for fluids responsible for vein formation indicate a metamorphic source. Fluid inclusions associated with gold at recrystallized quartz subgrain boundaries and within healed fractures are generally two-phase with a large vapour bubble and typically a liquid  $\text{CO}_2$  outer rim. Methane and other gas components are indicated and high, but variable, bulk homogenization/decrepitation temperatures (290° to 580°C) were obtained. Heterogeneous trapping, as a result of fluid- $\text{CO}_2$  separation, is suggested to explain the variation of fluid inclusion compositions. This would also provide a mechanism by which gold deposition could have occurred.

## 3. Alteration

The extent of wallrock-fluid interaction which may have occurred at Jasper has not been documented. Alteration of wallrock mineralogy is petrographically visible only within 2 to 3 m of the shear zone and consists of minor sericite and carbonate filling fractures and as overgrowths. The  $\delta^{18}\text{O}$  values of quartz obtained from drill holes which transect representative portions of the wallrock and mineralization indicate an alteration envelope of greater than 10 m laterally from the main zone. The  $\delta^{18}\text{O}$  values of the quartz from the host rock is up to 2 per mil greater than quartz in unaltered por-

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## REGIONAL HISTORY

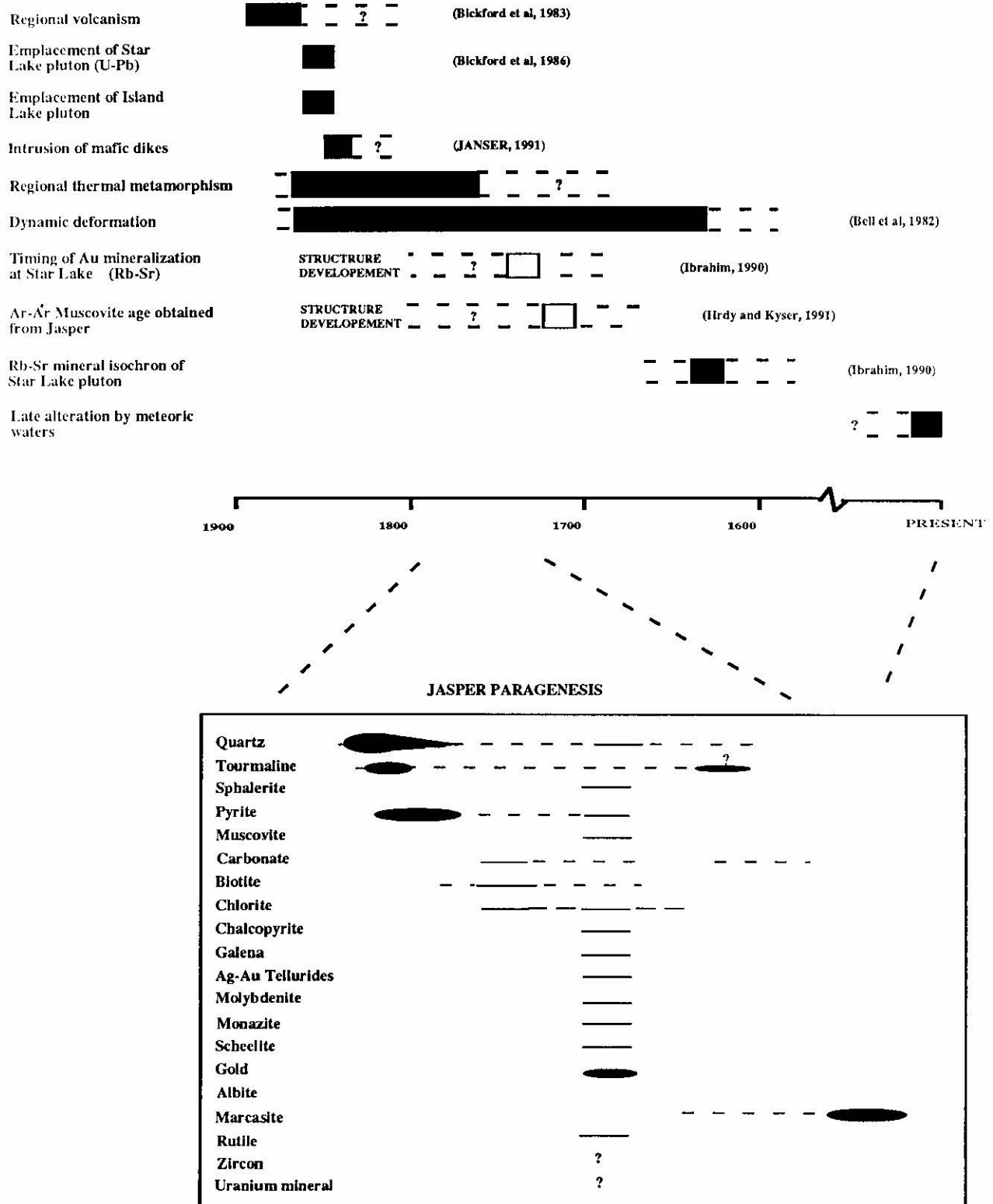


Figure 1 - Summary of geologic events for the La Ronge Domain and relative ages for vein mineralogy from the Jasper auriferous structure.

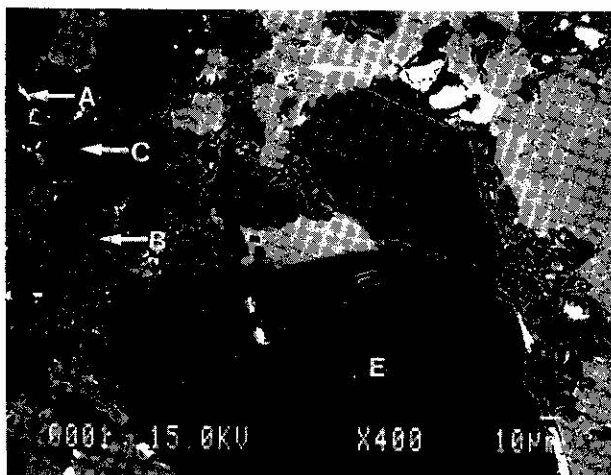


Figure 2 - S.E.M. photograph of microfractures within rafted wallrock in the vein hosting silver-gold tellurides. Muscovite and chlorite are also present. Darker regions coincident with fractures indicate potassium feldspar alteration to albite. A = silver-gold telluride; B = chlorite in microfracture; C = K-feldspar altered to albite; D = K-feldspar; E = tourmaline.

tions of the pluton. Quartz in the veins has  $\delta^{18}\text{O}$  values of 12 to 14 per mil whereas quartz from the pluton has much lower values of 8 to 9 per mil. As shown in Figure 1, the bulk of the quartz in the veins is not associated with the fluid that precipitated the gold so that the elevated  $\delta^{18}\text{O}$  values resulting from alteration do not necessarily reflect the presence of an auriferous fluid.

#### 4. Radiogenic Studies

$^{39}\text{Ar}/^{40}\text{Ar}$  dating of vein-derived muscovite yielded a date of 1710 Ma. The single zircon  $^{207}\text{Pb}/^{206}\text{Pb}$  evaporation technique, as described by Kober (1986, 1987) and Ansdell and Kyser (1990), provides an age of  $1855 \pm 8$  Ma for the Island Lake intrusion. Zircons have also been recovered from mineralized veins. During step heating of vein zircons,  $^{207}\text{Pb}/^{206}\text{Pb}$  ages as old as 3 Ga become progressively younger as temperatures are increased. This indicates the presence of older rims on the zircons which are a result of a reaction of the zircons with hydrothermal fluids that have interacted with Archean basement.

#### 5. Conclusion

The mineral inventory of the auriferous veins at Jasper is extensive and their paragenesis has been determined. Gold deposition occurred during vein deformation, but relatively late in the overall history of the structure. Fairly

extensive cryptic alteration of host rock is suggested and may indicate a high fluid/wallrock ratio during deposition of the majority of the quartz. Paragenetically, quartz deposition occurred prior to the introduction of auriferous fluids. Radiogenic dating supports late introduction of gold and provides evidence that Archean basement may have been one of the sources of the late auriferous fluids.

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